A DEMONSTRATION PROJECT BY

The Regional Municipality of Niagara

CRACK AND SEAT NIAGARA ROAD 1 (DOMINION
Town of Fort Erie

in co-operation with the
Ministry of Transportation of Ontario

THE REGIONAL MUNICIPALITY OF NIAGARA

Ontario

Ministry of Transportation

Ministère des Transports

INTRODUCTION

During 1990 the Municipal Roads Branch of the Ministry of Transportation of Ontario budgeted funds for demonstration projects to display to Ontario municipalities the potential benefits of new methods, products and systems. These projects were to demonstrate practical potential improvements in the productivity, efficiency, effectiveness, service or safety of municipal roads functions.

The funding formula for demonstration projects was the same as that used for normal supplementary allocations. However, a project may or may not be supported in its entirety using the supplementary allocation formula.

Niagara submitted an application for funding to crack and seat approximately one kilometre of rigid pavement on Niagara Road 1 (Dominion Road) between Kraft and Crescent in the Town of Fort Erie. The objective of the project was to crack and seat an old concrete roadway into a base course which would eliminate slab movement and, in turn, eliminate reflective cracking of the subsequent asphalt overlay.

In July, 1990, after due consideration, the Minister of Transportation of Ontario approved Niagara's application for funding in the amount of $81,650 which would support an expenditure of $89,800 (i.e. approximately 91% subsidy rate).

EXPLANATION OF THE PROBLEM

Niagara Road 1 (Dominion Road) in the Town of Fort Erie was a concrete roadway which had been constructed in approximately 1935 and subsequently overlayed with varying thicknesses of surface treatment and hot mix asphalt. The roadway was approximately 6.4 metres (21 feet) wide with a continuous centreline joint and transverse construction joints at varying

distances up to 18 metres (60 feet) apart. The original concrete roadway was constructed directly on the sub-grade with drainage provided by 60 centimetre (2 feet) deep roadside ditches for most of its length. (P1)

Over the years, through slab movement, transverse cracking of the concrete pavement had developed at intervals of between 1 1/2 metres (5 feet) and 4 1/2 metres (15 feet) apart. (P2) This cracking and the centreline construction joint crack then reflected through subsequent layers of asphalt overlay. (P3,4)

By cracking and seating the rigid pavement, Niagara hoped to achieve the following objectives:

1. The newly resurfaced roadway would be strengthened by reuse of the existing concrete as base material.

2. Reflective cracking would be eliminated.

3. With reflective cracking eliminated future maintenance (crack sealing, patching) would be greatly reduced.

4. Infiltration of water into the asphalt, base and subgrade would be greatly reduced thus prolonging the life expectancy of the roadway.

5. A distress-free roadway would be safer for the motoring public and reduce liability exposure.

PROJECT SUPERVISION

Staff decided that the preparation for crack and seating, the actual crack and seating, and preparation for the hot mix resurfacing would be carried out under the direction of the Transportation Services Maintenance Coordinator utilizing day labour forces. Direct on-site supervision would be the responsibility of a Roads foreman reporting to the Maintenance Coordinator.

The subsequent asphalt overlay including scratch, base and top

course was assigned to Engineering Services Division under the supervision of the Project Supervisor for roads rehabilitation.

The Maintenance Coordinator and the Project Supervisor worked closely together to ensure that scheduling of the work forces did not present a problem.

PRELIMINARY PREPARATIONS

Mapping and Photographic Records

Prior to undertaking the project a video tape was taken of the 1.0 kilometre section of roadway and a 0.5 kilometre control section established on the west end of the project section as requested by the MTO. 35 millimetre slides were also taken to illustrate typical reflective cracking and each crack was referenced for future mapping, again including the 0.5 kilometre control section.

Precondition Survey

Due to the nature of the project, staff were concerned that claims could arise from adjacent homeowners alleging damage to their buildings, driveways, etc., from the cracking operation. For this reason a private firm was retained to conduct an inspection of each property noting existing conditions, including defects, in the event that a future claim was made against Niagara.

Equipment Testing

Prior to commencing the cracking operation, staff met with the contractor on private property at an old cement plant facility which contained concrete roads similar to those on Dominion Road. With the permission of the property owner, the cracking equipment was tested at this location and satisfied staff's concerns that the equipment could effectively crack the concrete. In fact, the concrete at the test location measured greater than ten inches in thickness thus exceeding the thickest concrete anticipated on the Dominion Road site.

SITE PREPARATION

Test Pit Excavation

Prior to actual commencement of the demonstration project, a portion of Dominion Road was excavated to determine the method of construction.

It was revealed that the roadway had been poured directly on the sub-grade and that the concrete thickness varied from approximately 150 millimetre (6 inches) near the centreline to as much as 250 millimetre (10 inches) at the edge of shoulder. During the test excavations no evidence of reinforcing mesh or bars was discovered.

The asphalt overlay of the concrete pavement varied from a thin layer of surface treatment to several inches of hot mix overlay. In some areas, the concrete roadway was visible where the surface treatment had worn. (P5)

Asphalt Milling

Initially, some consideration was given to attempting the crack and seating operation without removing the thin overlay of surface treatment. However, leaving the overlay in place would prevent a thorough inspection of the underlying concrete pavement and could possibly act as a shock absorber during the cracking process and, therefore, it was decided to remove all asphalt overlays completely. (P6)

A local contractor was engaged to complete the milling operation consisting of approximately 1.5 kilometres of roadway at 6.4 metres in width. The length included a 0.5 kilometre control section adjacent to the project section which would not be cracked and seated but would be overlayed in order to observe the difference in performance of the overlay on a section of roadway which had been cracked and seated versus a section which had not been.

Milling operations commenced on September 27, 1990 and were completed on September 29, 1990. (P7)

During the milling operation, it was discovered that the concrete pavement on the north side of the roadway (3.1 metres wide) had been removed for a distance of 700 metres between Brighton Avenue and Ferndale . In addition, there were several small localized areas of previous concrete removal where full depth asphalt had been placed.

Since most of the asphalt removal had taken place in the intended control section, it was decided to add a portion of Dominion Road from Kraft Road easterly approximately 100 metres to the control section and which would not be cracked and seated. This section is located at the east end of the project.

Several small areas of severely deteriorated concrete were removed and replaced with full depth base asphalt (HL-8). (P8)

CRACKING AND SEATING

Equipment

The cracking operation was carried out using a guillotine hammer type breaker (P9) mounted on the rear of a International cab and chassis. The guillotine hammer measured approximately two metres in width and weighted approximately eight tonnes. The striking face of the hammer was constructed out of a piece of railroad steel measuring approximately 7.5 centimetres (3 inches) across the face. On to this 2.5 centimetre (1 inch) square iron bar was welded to concentrate the impact on the concrete pavement. (P10)

The equipment was controlled by two operators. A truck driver controlled the forward movement of the equipment while another operator seated behind the cab controlled the raising and dropping of the hammer itself.

Cracking Operation

Through trial and error, it was determined that the best cracking resulted from raising the hammer approximately 45 centimetres (18 inches) above the roadway and dropping it at intervals of 45 - 60 centrimetres (18 - 24 inches) along the pavement. (P11) In most instances, two passes were made in each lane of the roadway. One pass was made with the edge of the hammer touching the centreline construction joint and one pass with the edge of the hammer at the outside edge of the roadway adjacent to the shoulder. Every attempt was made to line up the second drop of the hammer directly opposite the first drop.

Observations

The resultant cracking of the concrete was difficult to observe. (P12) The cracks tended to be hairline and due to the roughness of the concrete in some areas (caused by the milling operation) the cracks were difficult to locate. Wetting of the surface with water helped to determine the crack pattern.

By close visual observation it was possible to mark the crack pattern utilizing white spray paint. This was done in several locations over varying distances of up to 12 metres (40 feet) in length to satisfy concerns that cracking was being achieved.

In general, the cracked pieces tended to measure approximately 60 centimetres X 60 centimetres (2 feet X 2 feet).

In some areas longitudinal cracking was easily achieved while transverse cracking was difficult to achieve. Speculation on the reasons for this included shock absorption by the sub-grade as observed by the slab movement during impact or possibly due to the configuration of the guillotine hammer striking high points left by the milling operation resulting in point loads and subsequent longitunal cracks.

When reinspecting these problem locations a day later, it was noted that transverse cracking had indeed occurred although not as frequently as in those areas where the transverse cracking was readily achieved. Again, the cracks were outlined utilizing white spray paint and it was noted that longitunal cracks were occurring approximately every 45 - 60 centimetres (18 - 24 inches) while transverse cracking was occurring approximately every 1.2 - 1.5 metres (4 - 5 feet).

Testing

In order to observe the surface cracking it was sometimes necessary to apply water which rendered the cracks visible. This was especially true in areas where the milling machine had roughed up the concrete surface. In other areas where the milling machine had not made direct contact with the concrete, the cracking pattern was relatively easier to observe.

A coring machine was used to take samples through both longitudinal and transverse cracks to ensure full depth cracking was achieved. Generally, a crack observed on the surface of the roadway did continue through to the sub-grade. In one instance, it was initially thought that the crack did not extend through the roadway but after the core sample had been exposed to water it could be seen that the crack did indeed extend through the sample. One core sample showed that undesirable lateral cracking had also extended through the slab. (P13)

For the most part, the core samples provided sufficient reassurance that the objective of full depth cracking had been achieved although with some instances of undesirable lateral cracking.

Seating

A thirty-five ton rubber-tired Gallion roller was used in the seating operation. (P14) The fully ballasted roller made four passes over each lane of the roadway. Two passes were made adjacent to the shoulder and two passes adjacent to the centreline.

Observations

For the most part, no discernible difference could be observed in the cracked pieces of concrete after the roller had passed over them.

Duration

The cracking and seating operation commenced on October 1, 1990 and was completed by October 4, 1990. The guillotine hammer suffered two breakdowns resulting in a loss of one-half day on one occasion and two hours on another.

PREPARATION FOR RESURFACING

Following both the milling operation and the cracking and seating operation the exposed concrete roadway was thoroughly swept using a broom mounted on the front of a tractor.

All major cracks (i.e. cracks that existed prior to the cracking operation) measuring approximately 1.25 centimetres (1/2 inch) or greater were thoroughly cleaned using brooms and compressed air. (P15) A tack coat was then applied to the cracks and asphalt was placed and rolled to seal the cracks. Any spalled concrete was also removed and repaired at this time. On October 5, following a heavy rainfall on October 4, the resurfacing crew moved on site and applied a tack coat and the levelling course of HL3 asphalt with a maximum thickness of approximately 25 millimetres (1 inch). On October 8 through 9 the base asphalt consisting of 50 millimetres (2 inches) of HL8 was applied. Then on October 12, 40 millimetres (1 1/2 inches) of HL3 was applied as the final top coat.

The paving operation went smoothly and the contractor was quite satisfied with the condition of the concrete roadway following the cracking and seating operation.

CONCLUSION

Several weeks following the resurfacing operation the roadway did not exhibit any surface cracking. Following the spring breakup in 1991 staff will closely inspect Dominion Road to determine whether any reflective cracking has reappeared. Obviously, it will be a couple of years before any reasonable conclusion can be drawn regarding the ability of the crack and seat method to eliminate reflective cracking.

COST CALCULATIONS

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MUNICIPAL ROADS OFFICE

1. Total Project Costs

Precondition Survey 26 properties @ $75	$ 1,875	
Milling 10,500 m^2 roadway & shoulder @$2.00/$m^2$	21,000	
Base repair, concrete joint repair	34,552	
Crack and Seat 5,425 m^2 @ $1.97/$m^2$	10,688	
SUB TOTAL	$ 68,115	
Resurface 1.0 km Crack and Seat Section including levelling, base & top course	$ 63,825	
Resuface 0.5 km Control Section including levelling, base & top course	$ 27,500	
TOTAL PROJECT COST	**$159,440**	
TOTAL UNIT COST (1.5 km X 6.4 m)	**$ 16.60/m^2**	

2. Cost to Crack & Seat & Resurface 1.0 km

	Precondition Survey	$ 1,875	
	Milling 6400 m^2 @ $2.00/$m^2$	12,800	
	Base & Joint Repairs	23,034	
*	Crack & Seat 5,425 m^2 @ $1.97/$m^2$	10,688	
	SUB TOTAL		$ 48,397
	UNIT COST ($48,397 - 6,400 m^2)	**$7.56/$m^2$**	
	25 mm Levelling Course HL3 @ $39.50/tonne	$ 9,745	
	50 mm Base Course HL3 @ $32.00/tonne	23,255	
	40 mm Top Course HL3	30,825	
	SUB TOTAL		$ 63,825
	TOTAL COST CRACK & SEAT AND RESURFACE		**$112,222**
	UNIT COST ($112,222 - 6400 m^2)	**$ 17.53/m^2**	

*NOTE: Some concrete roadway had been previously removed and replaced with asphalt.

Alternate Construction Cost Estimate

1. Cold Mix Resurface

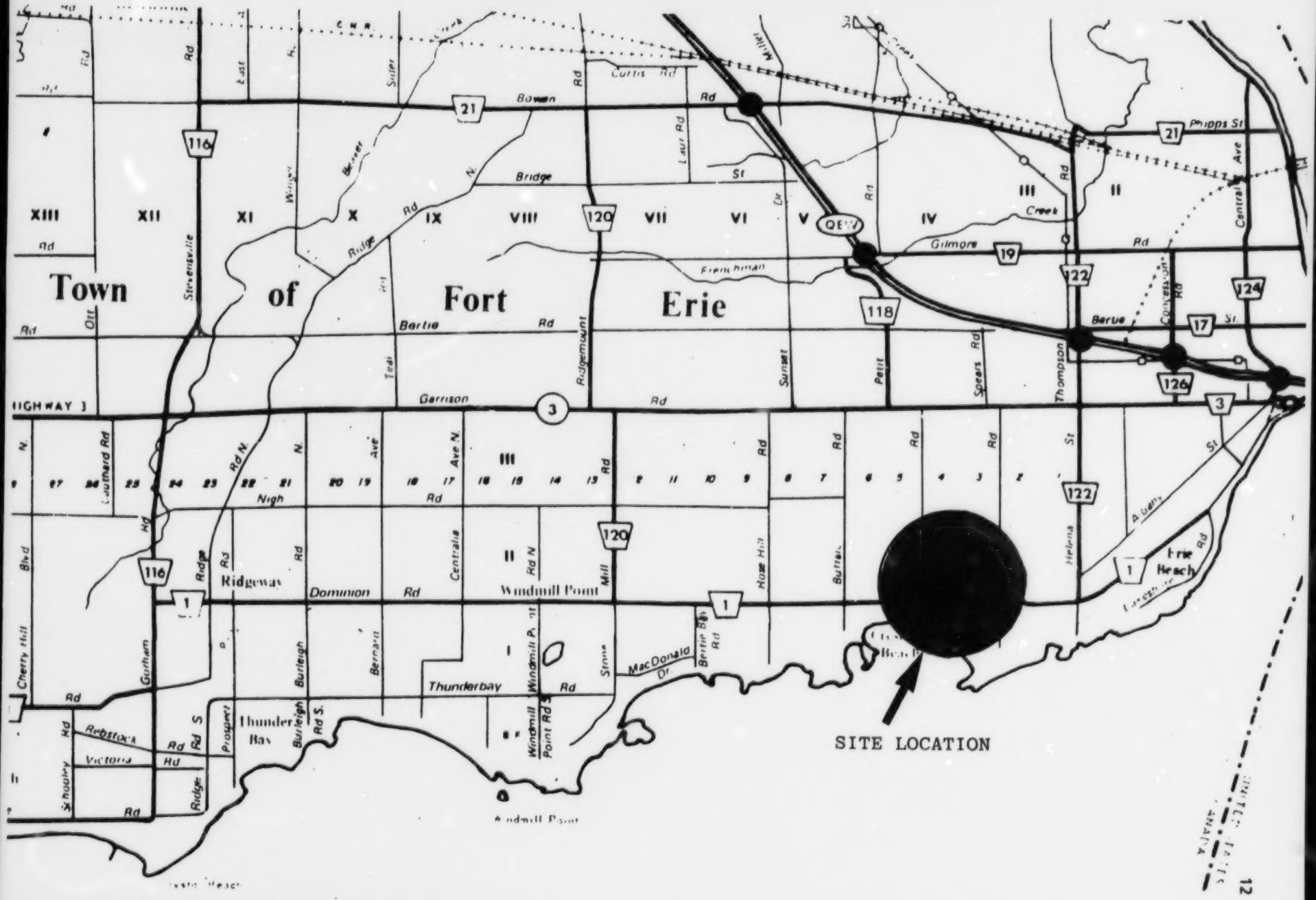
1.5 km open graded cold mix @ 127 mm (5") centreline thickness including levelling course, 2 m (6 1/2') shoulders, and excluding milling operation	$121,215	($12.63/$m^2$)

2. Hot Mix Overlay

1.5 km hot mix resurfacing including base repair, tack coat, 1.5 km 50 mm (2") base asphalt (HL8), 40 mm (1/1/2") top asphalt (HL3), 2 m (6 1/2') shoulders and excluding milling operations	$115,000	($11.98/$m^2$)

3. Reconstruction

1.5 km complete reconstruction including removal of existing pavement structure, 550 mm (22") granular base, 80 mm (3") base asphalt (HL8), 40 mm (1 1/2) top asphalt (HL3) and 2 m (6 1/2') shoulders	$986,000	($102.71/$m^2$)


Town of Fort Erie
SITE LOCATION
Ridgeway
Thunderbay
Windmill Point
Thunder Bay
Dominion Rd
Garrison Rd
Bertie Rd
Bowen Rd
Bridge St
Ridge Rd
Gilmore Rd
Phipps St
Berue St
Central Ave
Erie Beach
HIGHWAY 3
QEW
116
120
118
122
124
126
21
19
17
3
1

DEMONSTRATION PROJECT

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P1 TYPICAL ROADSIDE DRAINAGE DITCH

DEMONSTRATION PROJECT

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P2 TYPICAL CRACKING PATTERN

DEMONSTRATION PROJECT

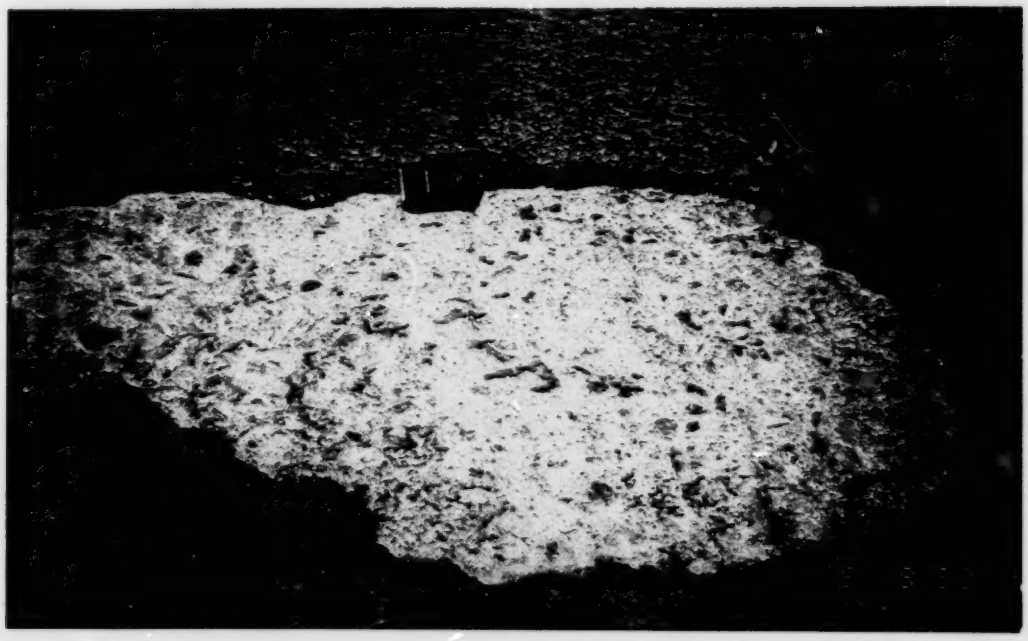
CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P3 TYPICAL TRANSVERSE CRACK AND CENTRELINE CONSTRUCTION JOINT REFLECTED THROUGH ASPHALT OVERLAY

DEMONSTRATION PROJECT

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P4 TYPICAL TRANSVERSE CRACK
REFLECTED THROUGH ASPHALT OVERLAY



P5 EXPOSED CONCRETE AT SURFACE TREATMENT

DEMONSTRATION PROJECT

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P6 ASPHALT MILLING OPERATION IN PROGRESS

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P7 DOMINION ROAD AFTER ASPHALT MILLING

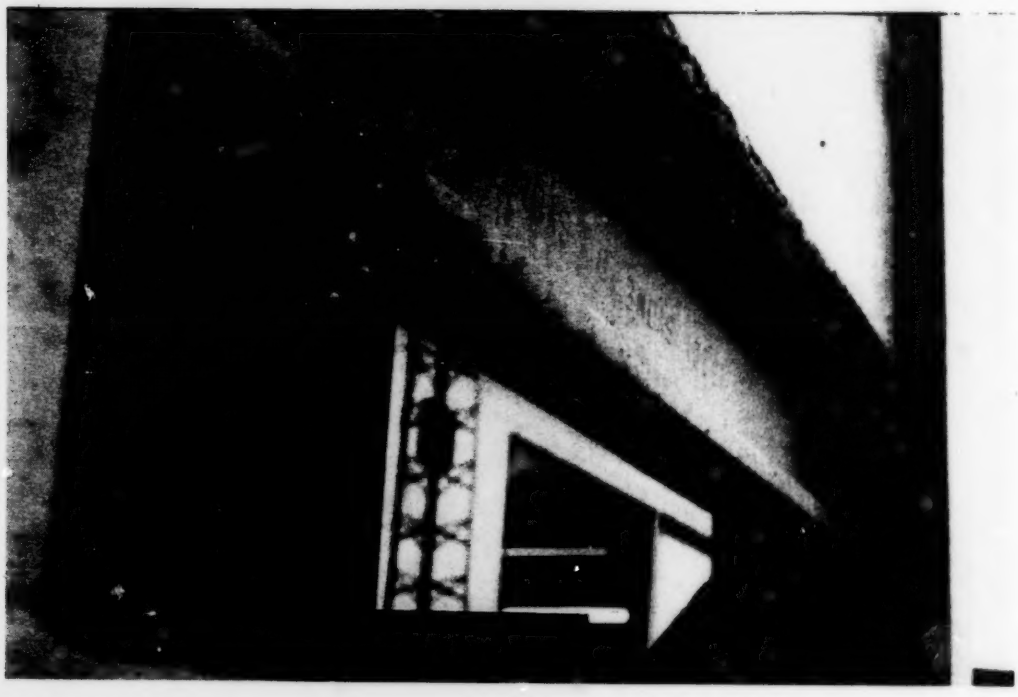
CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P8 AREA OF CONCRETE REMOVAL
PRIOR TO FULL DEPTH ASPHALT REPAIR
(AFTER MILLING)

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

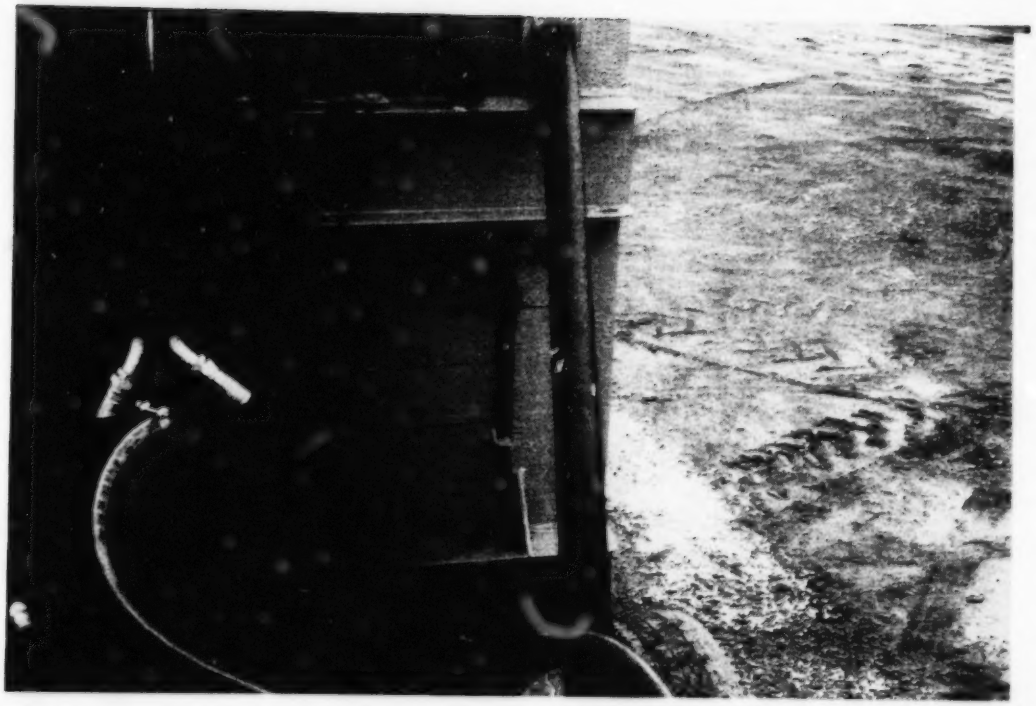
P9 GUILLOTINE HAMMER-TYPE BREAKER

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE



P10 STRIKING SURFACE OF GUILLOTINE HAMMER

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE



P11 INDICATES HEIGHT OF HAMMER FACE ABOVE PAVEMENT

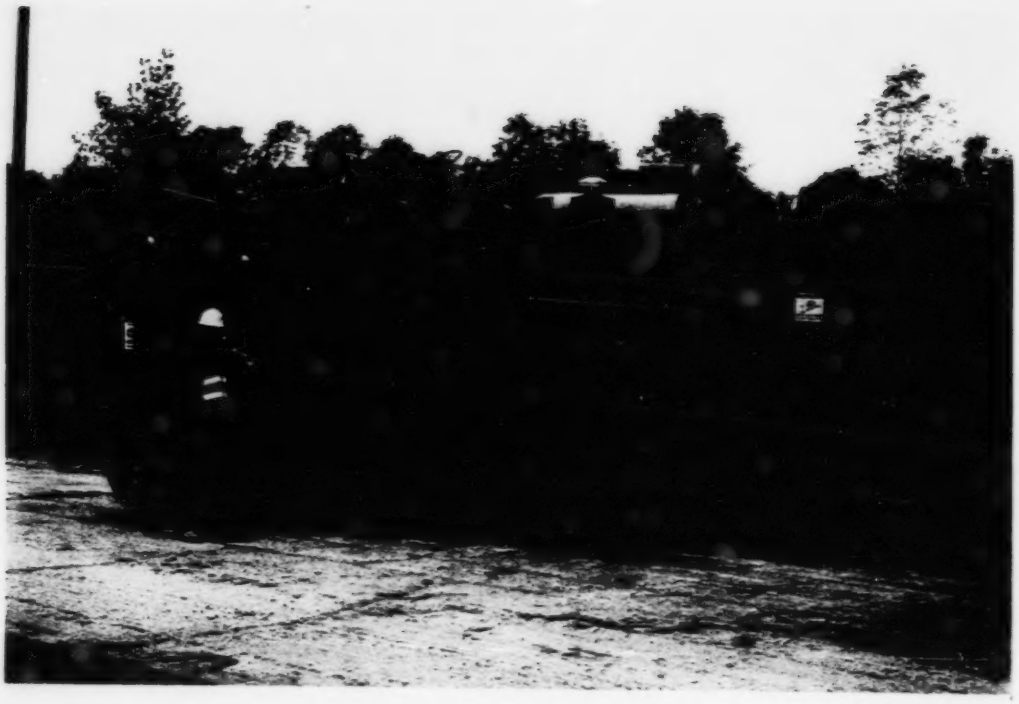
CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P12 AFTER SPRAYING WITH WHITE PAINT SURFACE
CRACK SHOWS IN CORE SAMPLE

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P13 CORE SAMPLES ILLUSTRATE EXTENT OF CRACKING
(SAMPLE B ILLUSTRATES UNDESIRABLE LATERAL CRACKING)

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE



P14 35 TON PNEUMATIC RUBBER TIRED ROLLER

CRACK AND SEAT NR1 (DOMINION ROAD) TOWN OF FORT ERIE

P15 CLEANING OF CRACKED CONCRETE PRIOR TO SEALING WITH ASPHALT